3D Reconstruction and 3D Point Cloud Compression

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Abstract. 3D reconstruction and 3D Point Cloud Compression of image sequences is an important application in computer graphics and image processing, especially in biomedical engineering. Based on the introduction of the basic principle of 3D reconstruction, this paper presents a simple and easy implementation process of 3D reconstruction, and focuses on the key technologies of point cloud acquisition, finally, the future research directions of 3D Point Cloud Compression is discussed.

Introduction

3D reconstruction models provide an interesting analysis tool for the diagnosis and the follow-up of many bone diseases. The 3D bone models play also an important role in preoperative surgery planning and improved guidance during surgery, modeling and simulation. A direct 3D imaging must be developed, as an alternative to current 2D radiographs, in order to assist the clinicians on their medical tasks. However, reconstructing a 3D bone shape from a restricted number of 2D X-ray images is a challenging task, especially when reconstructing a patient bone specific surface model. Moreover, for surgical application, high accuracy reconstruction is required. The error of reconstruction has to be in the range of surgical usability.

The research on it is of great practical significance. Specific performance in:

(1) In the film and television industry, it can be obtained in the actual difficult to capture the special perspective effect. For particularly high buildings, to get it to look up at the map is very easy, but when it gets flat view or view, you need to set up a high altitude operation. However, when using IBMR to obtain the structure of the scene, it is convenient to observe from different perspectives.

(2) In the scene of the crime and the reconstruction of the traffic accident, the scene will be cleaned and restored to its normal function after the investigation and evidence collection. Therefore, most of the crime scene is transient. It is necessary to capture the virtual scene as the original scene and use it for the next investigation, analysis and evaluation of the witness testimony, as well as the filing of the case.

(3) It plays an important role in the preservation of cultural relics and ancient buildings. With the passage of time and the impact of human activities, artifacts are constantly being destroyed, how to have the precious value of the material wealth preservation is flawless and perfect global issues imminent. The use of IBMR for the treatment of precious cultural relics, the completion of the digital museum can be better.

(4) To solve the contradiction between the rich exhibits and limited exhibition space and time, and to further develop the new field of protection, research and display of Museum collections. In the unmanned and machine vision, it is important to guide the machine to make decision by using the method of 3D spatial distance. Through the placement of a certain number of equipment in the camera, shooting some scenes in the real image, through the camera calibration and a series of work out between the points in the scene with the viewpoint of the distance. According to this, we can finish the work of machine navigation and machine picking.
Principle and Process of 3D Reconstruction

Based on the image reconstruction technology is mainly refers to the adoption of a hand-held camera around the reconstruction of the object to take a set of image sequences, the use of related technologies to restore the three-dimensional model of the object. As shown in figure 1.

![Algorithm flow](image)

Figure 1. Algorithm flow.

Feature Points Detection and Matching

Feature matching is to find the same point in the space in the image corresponding to the projection point, commonly used gray based matching method and feature-based matching method. The neighborhood matching method and point based on the gray related to a feature point in the image, matching the search in another image with a window matching criterion for NCC (normalized cross correlation) or ZNCC. But the method in the two image scale differences, regional image distortion is more serious, the texture information poor, correct matching rate will be very small, even the failure of matching. Feature based image matching method is to achieve the matching through the gray mathematical symbols, because it is not directly using the window to match, it is relatively stable for illumination, contrast, scaling and rotation.

Computing Basis Matrix

The fundamental matrix not only contains the rotation and translation information of two cameras in the physical space, but also contains the internal parameters of the two cameras. It is shown that: given a feature point on an image, it must be on the corresponding epipolar line in the other image. The fundamental matrix can not only transform the two-dimensional search matching problem into one-dimensional search along the epipolar line, but also eliminate many false matching points.

When there are many pairs of matching points, many equations can be established. Scholars have done a lot of research on the solution of the fundamental matrix. The basic matrix estimation algorithms are divided into linear algorithm, iterative algorithm and robust algorithm.

Camera Calibration

Camera calibration is to find out the internal parameters of the camera. According to the fundamental matrix, the projective reconstruction of the object can be obtained, but the projective reconstruction cannot accurately express the size information of the object, which must be completed by the Euclidean reconstruction. Research on camera calibration are many, mainly divided into the use of calibration for calibration, camera self calibration and the use of camera calibration vanishing line. Zhang Zhengyou's plane calibration method, calibration method Xiaoqiao Meng and Hu Zhanyi circle, parallel circle calibration method such as Wu Yihong is with the help of calibration for calibration. Camera self calibration method is the process of using the corresponding relationship between the image and the camera to calibrate the camera, which is based on the Kruppa equation and the self calibration method based on the absolute two surface and infinite plane. The vanishing point out line calibration, the structure of the scene has certain requirements.
Calculate the Camera External Parameters and Restore the Projection Matrix

For two images, can be the first image corresponding to the camera coordinate system that is the world coordinate system, calculate the second images corresponding to the camera coordinate system relative to a camera coordinate system rotation matrix and translation matrix R T, set in the coordinate system, the rotation matrix and translation matrix and camera is second camera external parameters relative to the world coordinate system.

3D Point Cloud

In order to make the reconstructed object smooth enough, it is necessary to obtain dense 3D point cloud. The 3D point cloud is obtained by two dimensional matching, that is to say, the dense matching points must be found on the image. The dense matching algorithm has the right to put forward the method of the Dragon: it is calculated for each matching point intensity, and rank, matching strength, then the similarity of two high, then there must exist in their potential matching points, to find the matching points, diffusion [6] populated by setting a certain the window. In addition to the epipolar constraint of matching points is dense stereo matching, but before the dense matching must be image correction, which aligns the two images, which is convenient in another image search and a point matching point in the first image. After the dense matching is completed, the 3D space points are obtained by projection matrix or parallax. Process shown in Figure 2.

According to the above process, the final result is a 3D point cloud, which is based on the intermediate results of image reconstruction. Since the point cloud is discrete, it can only be used to describe the contour of the reconstructed object. In order to further improve the results, we also need to complete the triangular mesh reconstruction, texture mapping and other operations.

Using a cube as the calibration of camera calibration, to determine the world coordinates of the corner cube in the world coordinate system is shown in Figure 3, then hold the camera to shoot a Rubik's cube image, the image size is 640 * 480, the camera focal length is 6 mm. in the next image in the feature point the order and position, and in the world coordinate consistent feature points as shown in Figure 4.
Then keep the camera intrinsic parameters unchanged, that does not change the camera focal length and image size, on a tray and a book by 3D reconstruction experiment, the tray placed on the book, two images were taken from the upper left and right, select the feature point. Using linear method to solve the basic matrix \([8]\), through the projection matrix for space points. Then the mesh reconstruction, texture mapping, this experiment is in the VRML directly to the surface, and paste the texture, the results of reconstruction as shown in Fig.6. From the results of reconstruction can be seen, according to the above process can be completed reconstruction, and get good visual effects.

![Figure 5. Image based reconstruction result.](image)

**3D Point Cloud Compression Research Direction**

First, the establishment of an effective evaluation model. At present, there are many compression methods for 3D Point Cloud Compression with fruitful results based on grid division and curvature and so on. But there are still blanks in the evaluation of the compression effects of the algorithm, with no literature records on the quality evaluation of the algorithm to be found. However, judging from whether compression is good or not in vision is not good enough to determine the quality of compression, while the research on the establishment of effective evaluation model is helpful to improve the active control ability of the model data compression. Therefore, there is a great practical significance for the work of compression and evaluation of the point cloud data.

Second, explore the 3D Point Cloud Compression model based on shape analysis. Through the recently preliminary surveys, it is found that the existing methods are based on local topology or geometric information for model traversal and coding, without the efforts to understand the overall shape of the object. Some of the regional shapes of the model surface are repeated in multiple places (there may be some minor differences). We can locate these similarities, and only a representative sample is needed to be encoded for similar regions, each of which is only the instantiation and error correction process of a regional representative. The study is to explore the compression algorithm of 3D Point Cloud model based on shape analysis, that is, we will try to analyze and understand the structure of the 3D point cloud model or find the similarity between different local regions, so as to improve the data reuse rate, reduce the entropy of the data and increase the compression rate of the data.

Third, in the 3D Point Cloud Compression algorithm, the new topological connection between the vertex vertices needs to be found, which is not just within the minimum spanning tree, but the consideration of optimizing the minimum spanning tree or defining the new data structure to improve the compression efficiency and running time for the algorithm theoretically.

**Conclusion**

According to the basic principle of 3D reconstruction based on image, this paper presents a simple and feasible implementation process and discussed the research direction of 3D Point Cloud Compression. The experimental results show that the given process can be used to reconstruct 3D images with two images.
References


